OMAHA DISTRICT
U.S. ARMY
CORPS OF ENGINEERS

Chemical Data Quality Assessment Report (CDQAR)

For

Soil Samples Obtained at

North Fork of Clear Creek, Colorado

April 2003

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ACRONYMS AND ABBREVIATIONS

ABA	Acid Base Accounting
ADP	Analytical Data Package
ASTM	American Standard Testing Materials
^{o}C	Degrees Celsius
CDMG	Colorado Division of Minerals and Geology
CDQAR	Chemical Data Quality Assessment Report
CENWO	Corps of Engineers, Omaha District
COC	Chain-of-Custody
DQCR	Daily Quality Control Report
DQOs	Data Quality Objectives
DUP	Duplicate
eV	Electron volt
ECB	Environmental Chemistry Branch
EPA	Environmental Protection Agency
FSP	Field Sampling Plan
Ft	Foot/Feet
GPS	Global Positioning System
HSA	Hollow Stem Auger
I.D.	Inner Diameter
IDW	Investigative Derived Waste
Kg	Kilogram
L	Liter
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
MDL	Method Detection Limit
MRL	Method Reporting Limit
µg/L	Micrograms per Liter
mg/kg	Milligrams per kilogram
mg/L	Milligrams per Liter
mg	Milligram
Min	Minute
mL	Milliliters
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MW	Monitoring Well
N/A	Not Applicable
ND	non-detect
NPDES	National Pollutant Discharge Elimination System
O.D.	Outer Diameter
PID	Photoionization Detector
ppb	Parts per Billion (measured in water as µg/L)

QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAMS	Restoration of Abandoned Mine Sites
RPD	Relative Percent Difference
SSHP	Site Safety Health Plan
SOP	Standard Operating Procedure
SSA	Site-Specific Addendum
TMDL	Total Maximum Daily Load
U.S.	United States
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
WRDA	Water Resource Development Act

1 INTRODUCTION

1.1 QUALITY CONTROL SUMMARY

This Chemical Data Quality Assessment Report (CDQAR) describes the operations and procedures followed by USACE to conduct the investigation of soil and sediment samples obtained from the abandoned mine area of North Fork of Clear Creek, Colorado. Field work was performed by USACE Omaha and Albuquerque Districts. Analytical services were provided by a US Army Corps of Engineers laboratory, the Environmental Chemistry Branch Laboratory located in Omaha, Nebraska.

The field and sample analyses were performed in accordance with the general Site Work Plan for the Restoration of Abandoned Mines prepared by U.S. Army Corps of Engineers, Omaha District, Omaha, Nebraska, July 2002 and the Site Specific Work Plan for the North Fork of Clear Creek, Colorado, August 2002.

This CDQAR includes a summary of the quality assurance (QA) and quality control (QC) procedures and an evaluation of data quality and data usability with respect to Data Quality Objectives (DQOs) established for this field investigation.

1.2 REPORT ORGANIZATION

Section 2 of this report provides a discussion of project objectives. Procedures employed to control and evaluate the quality of sample collection, transportation, storage, and analysis are presented in Section 3. Section 4 discusses data evaluation, and the results of QC evaluations are in Section 5. Conclusions and recommendations are presented in Section 6.

2 PROJECT DESCRIPTION

2.1 PROJECT PURPOSE

The primary objective of this field investigation is to collect and provide surface soil and sediment data to the CDMG and USBR to support their respective investigations for the North Fork of Clear Creek drainage. This data may eventually be used by the CDMG and/or the USBR in order to determine metals loading from various mine waste pile sites to the North Fork of Clear Creek drainage.

2.2 ANALYTICAL SERVICES

The Environmental Chemistry Branch (ECB) laboratory provided analytical services for total metals of the soil/sediment samples and total metals, pH, acidity and conductivity of the water leachate from the soil/sediment samples. Laboratory address is given below:

US Army Corps of Engineers
Environmental Chemistry Branch (ECB) Laboratory
420 South 18th Street
Omaha, NE 68102

ECB Laboratory reported all non-detect results as "u". The non-detect values are given in the data tables as 'u' less than the Method Detection limits (MDL). The MDL is the minimum concentration of a substance that can be measured and reported with 99 per cent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. The reporting limit (RL) is determined by the laboratory and takes into account impacts from sample matrix, sample preparation, and instrument limitations. The RL represents the concentration at which the laboratory can both determine the presence of an analyte and accurately quantify the amount present. The laboratory reported detections below the RL and higher than the MDL with a "J" laboratory qualifier, which indicates a greater degree of uncertainty associated with the quantitative result. The J qualified values are considered valid and useable. Reporting limits may increase for an individual environmental sample due to high concentrations of target analytes, matrix effects, or other interferences.

2.3 DATA QUALITY OBJECTIVES

The DQOs for this site are based on the objective of the investigation, which is to collect soil data of sufficient quality so that the data users can assess the effects of former mine operations at this area and then evaluate the need for any additional response action.

2.3.1 Data Collected

The data collected at the North Fork of Clear Creek were from samples obtained from soil/sediment samples and sent to the labs given above.

Field Measurements (Field Screening Data)
No field screening of samples were performed.

Off-Site Analysis (Definitive Level Data)
Definitive level data was collected from twenty-seven (27) soil sample locations and four (4) sediment sample locations. The total number of soil samples analyzed was 31 soil samples (27 primary samples plus four QC samples) and five sediment samples (four primary samples and one QC sample). All samples were analyzed for total metals. The water leachate derived from these same soil samples was also analyzed for total leachable metals, pH, acidity, and conductivity. The metals suite is: Al, As, Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, K, Ag, Zn. Sections 3.0 and 4.0 give the field and laboratory quality control procedures and the result of the quality control process is given in Section 5.0. The data quality objectives for this data are to ensure that the data adheres to criteria in Sections 3.0, 4.0, and 5.0.

3 FIELD QUALITY CONTROL PROCEDURES

3.1 PROJECT PLANNING

The field investigation was conducted as described in the Site Specific Work Plan for the North Fork of Clear Creek, Colorado, 29 August 2002. The plan was written by CENWO to ensure the quality of data derived from the investigation. The plan provides a discussion of the project work scope and general procedures to be followed for field and laboratory activities.

3.2 DOCUMENTED FIELD ACTIVITIES

This section summarizes the equipment, procedures, and methods undertaken to ensure quality of the sample collection activities. Investigation activities and QC procedures were recorded and documented in the field using appropriate field forms. Prior to sample collection, as well as between sample locations, field equipment was decontaminated.

3.2.1 Soil/Sediment Samples

A total twenty-seven (27) soil samples and four (4) sediment samples were collected by CENWO personnel between 9 –13 September 2002 and were sent off site for analysis.

3.2.2 Management of Investigation Derived Waste (IDW)

IDW was handled as described in the Site Specific Work Plan for the North Fork of Clear Creek, Colorado, August 2002.

3.2.3 Decontamination Procedures

The field instruments were decontaminated in the field as described in the Standard Operating Procedures.

3.2.4 Other Documentation and Reporting of Field Activities

All field activities were thoroughly documented in indelible ink using the following forms:

- Field Data Sheets
- Chain of Custody Record
- Sample Labels

Field personnel initiated Chain of Custody (COC) documentation as samples were collected and selected for laboratory analysis. Sample custody was maintained from sample collection through the completion of the laboratory analysis.

3.2.5 Sample Labeling, Handling, and Shipping

All documentation, handling, and shipping employed for this field effort were in concurrence with the procedures described in the Work Plan.

Labeled samples were placed in sealed Ziploc brand bags and packed in waterproof plastic ice chests with sufficient packaging material placed around and between the sample jars. Sample containers and holding times used for this project are shown in Table 3-1.

Every cooler contained a COC form, prepared in triplicate, which identified all of the sample containers, analytical requirements, time and date sampled, preservatives, and other pertinent field data. Samples were shipped by an overnight courier to ECB Laboratory to enable analysis within holding times. Upon receipt in the laboratory, the Sample Custodian opened the shipping containers, compared the contents with the COC record, ensured that the document control information was accurate and complete, and dated the form. A Sample Receipt Form was also used by the laboratory to log in samples and document their integrity upon arrival. These forms are provided in the Analytical Data Packages.

3.3 FIELD QUALITY CONTROL SAMPLES

Duplicate samples were collected for this field effort as follows: four soil samples and one sediment sample. The results of the field QC samples and their impact on data quality are discussed in Section 4.

Table 3-1
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES
FOR COMPOSITE SOIL SAMPLES

Parameter	Container	Maximum Holding Times	
		Digestion	**Analysis**
Composite Soil Sample*			
Metals[1]	1 x 8 ox Glass	6 months (Mercury – 28 days)	6 months (Mercury – 28 days)
Water Leachate**			
Leachate Metals[1]		6 months (Mercury – 28 days)	6 months (Mercury – 28 days)
Leachate pH			ASAP***
Leachate Acidity			ASAP***
Conductivity			ASAP***

* One 8 oz jar obtained in the field from each area is sufficient for all analyses.

** The water leachate process is performed in the laboratory by the method described in the Site Specific Work Plan..

*** ASAP in this instance means as soon as possible after leachate is obtained.

[1] Al, As, Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, K, Ag, Zn

4 EVALUATION OF DATA QUALITY

The laboratory analytical data was reviewed and verified by ECB Laboratory and then evaluated by the CENWO project chemist for compliance with project objectives.

The following section is a description of the laboratory review procedures used to ensure data quality and the project chemists' assessment of project deliverables. Data usability was determined by comparing the project DQOs against the quality of the final analytical results.

4.1 LABORATORY QUALITY CONTROL SAMPLES

This section provides a description of laboratory QC samples: laboratory control samples, method blanks, and surrogate spike samples (organic analyses only), and matrix spike/matrix spike duplicate.

4.1.1 Laboratory Control Samples (LCS)

The laboratory analyzed a spike blank sample in duplicate to evaluate the precision and accuracy within an analytical batch. The nomenclature for these samples is a laboratory control sample (LCS). LCS sample pairs consisted of analyte-free water that was spiked with selected target compounds. LCS results are included in the QC section of each laboratory's data package, which are included in the Analytical Data Packages.

4.1.2 Method Blank Analyses

A laboratory method blank is a contaminant free matrix sample (e.g. a method blank is often a volume of distilled water carried through the entire analytical scheme) that is subjected to the same analytical procedures as the field samples. The method blank is used in all analyses to verify that the determined concentrations do not reflect contamination. One method blank is performed with every batch of samples (approximately 20 samples). If consistent high blank values are observed, laboratory glassware and reagents are checked for contamination and the analysis is halted until the system is brought under control.

4.1.3 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The laboratory analyzed a spiked environmental sample and duplicate to evaluate the performance of the method as applied to a particular project matrix. A MS is an environmental sample in which known concentrations of certain target analytes have been added before sample manipulation from the preparation, and determinative procedures have been implemented. The results of the MS are evaluated in conjunction with other QC information to determine if the effect of the matrix can bias the analysis.

4.2 LABORATORY DATA VALIDATION ACTIVITIES

All analytical data generated by ECB Lab was checked for completeness and evaluated for overall quality prior to final report generation as outlined in the Quality Assurance Program Plan (QAPP) and specified in each laboratory's Standard Operating Procedures (SOPs). This process consisted of data generation and reduction plus three levels of documented review. Each step of the review process involved evaluation of data quality based on QC data results and the professional judgement of the reviewer(s). All reviews were documented by the reviewer's signature and the date reviewed.

The analyst who generated the raw analytical data performed the first level review. Primary emphasis of the review was on correctness and completeness of the data set. All data were generated and reduced following method-specific SOPs. Each analyst reviewed the quality of the work based on the guidelines established in the SOP. The first review ensured that:

- Sample preparation and analysis information was correct and complete;
- The appropriate SOPs had been followed;
- QC parameters were within method control limits; and
- Documentation was complete

The second level review was structured so that all calibration data and QC sample results were reviewed and 10 percent of the analytical results were confirmed against the bench and instrument sheets. This shall include a complete review of instrument data scans to ensure accurate peaks and retention time, and correct peak integrations have been performed. If no problems were found with the data package, the review was considered complete. If any problems were found with the data package, an additional 10 percent of the samples were checked to the bench sheet. The process was continued for each batch until no errors were found or until each data package was reviewed in its entirety. All second level reviews were performed by a laboratory supervisor, data review specialist, or QA officer to ensure that:

- Calibration data were appropriate to the method and completely documented;
- QC samples were within established guidelines;
- Qualitative identification of sample components was correct;
- Quantitative values were calculated correctly;
- Documentation was complete and correct;
- The data were ready for final reporting; and;
- The data package was complete and ready for data archive.

An important element of the second review was the documentation of any errors identified and corrected during the review process.

Before the final report was released, a third review was performed to check each data package for completeness and to ensure that the data met the overall objectives of the project. The laboratory Program Administrator, as stated in the QAPP, did this review. The review was performed to ensure that:

- Target analyte lists were complete as specified in the sampling and analysis plan;
- Data package checklist items were present;
- Case narratives accurately documented analytical conditions;
- All non-conformances were addressed and closed.

The Analytical Data Packages (ADPs) contain the following:

- Cover page, identifying project and remarks
- Summary and discussion of method QC and shipping and/or chain-of-custody errors

- Sample receipt information including copies of Cooler Receipt Forms
- Chain-of-Custody (COC) information including copies of COCs
- Analytical Test Results

As part of the review process, both contract laboratories applied data qualifiers to specific results to indicate usability and/or special analytical conditions. The following qualifiers were used to flag data:

B	The compound was also observed in the method blank.
J	Estimated concentration below the Reporting Limit.
u	The compound was not detected.
M	Reporting limit higher than normal due to matrix interferences.
D	Derived from a dilution of extract.

All investigative and QC sample summary results have been submitted in the Analytical Data Packages. A summary of laboratory quality control issues is found in the data package. The data package as obtained from the laboratory is attached as Appendix B.

4.3 CENWO PROJECT CHEMIST QUALITY EVALUATION

In addition to the internal validation conducted by ECB Lab, the CENWO project chemist performed data validation of the data set. This included an evaluation and validation of samples based on:

- Initial sample inspection and COC documentation;
- Holding Times;
- Field Duplicate Analyses;
- Laboratory Control Samples;
- Method Blank Analyses;
- Matrix Spike/Matrix Spike Duplicate recoveries;
- Precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters as they apply to this CDQAR; and
- An overall assessment of data compared to the project DQOs.

The CENWO project chemist received data from the laboratory in hard copy format. The USACE Guidance for the Review of Performance-Based Definitive Chemical Data was used to perform the review and validation of the data.

The first step in evaluating and validating the data was to group the samples according to analytical batch or work group. A table was generated which show all analytical batches (project samples and laboratory QC samples). The batches are shown on Table 4-1. After analytical batching, the batches were reviewed to ensure that the proper QC (type and frequency) was analyzed according to the QAPP for each batch. Next, sample duplicate frequency was evaluated for compliance with the QAPP. Chain-of-custody forms and Cooler Receipt Forms were then reviewed. Any problems found were documented and the impact on sample results was determined and explained.

Holding times were evaluated for compliance with extraction and analysis holding time requirements. Matrix spike recoveries were evaluated for all samples. MS/MSD results were re-calculated on at least one sample per batch. Data qualifier flags were applied as appropriate. Surrogate spike recoveries were evaluated for all samples and surrogate recoveries were re-calculated on at least one sample per batch.

Next, LCS results were reviewed for all samples. LCS recoveries were re-calculated on one sample per batch. Relative Percent Differences (RPDs) for MS/MSD and LCS/LCSD pair calculations were verified for all batches. The 5X and 10X rule (as discussed in the Functional Guidelines for the Evaluation of Chemical Data) was used for evaluation of method blank results. The completeness percentage for surrogates, LCS, MS/MSD and holding times was then calculated.

A summary of the data review/validation results is given in section 5.

As discussed previously, data qualifier flags were applied to out-of-control data as appropriate. The following qualifiers were used to indicate data usability:

u: The analyte was not detected relative to the method reporting limit.

UN: The result is reported as a tentative non-detection. There is uncertainty with whether or not the non-detection is valid at the stated method reporting limit.

X: The data is tentatively rejected because project-specific data quality objectives have not been met or have not been demonstrated.

J: The target analyte is positively identified but the quantitative result is an estimate and the direction of bias is unknown. The flag indicates a significant quantitative (rather than a qualitative) uncertainty exists.

J-: The target analyte is present but the reported concentration is an estimated value that is believed to be biased low. (i.e. the actual concentration in the environmental sample believed to be higher than the reported concentration)

J+: The target analyte is present but the reported concentration is an estimated value that is believed to be biased high. (i.e. the actual concentration in the environmental sample is believed to be lower than the reported concentration)

R: Data is rejected due to the serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified. The data is not useable.

Daily Quality Control Reports and COC documentation were compared against laboratory reports to check conformity of sample identification numbers. Analytical results were compared

to daily activity logs to identify sampling procedures/activities that may have impacted data quality.

Table 4-1 Analytical Batches

North Fork Clear Creek, Colorado

Batch	Analyses	Sample ID
WG11258	Metals (soil)	CO-NCC-CHG02-SS11
		CO-NCC-CHG02-SS10
		CO-NCC-CHG02-SS11 dup
		CO-NCC-CHG02-SS09
		CO-NCC-CHG02-SD-01
		CO-NCC-CHG02-SD02
		CO-NCC-CHG02-SS07
		CO-NCC-CHG02-SS06
		CO-NCC-CHG02-SS04
		CO-NCC-CHG02-SS16
		CO-NCC-CHG02-SS15
		CO-NCC-CHG02-SS02
		CO-NCC-CHG02-SS08
		CO-NCC-CHG02-SS08 dup
		CO-NCC-CHG02-SD-03
		CO-NCC-CHG02-SS14
		CO-NCC-CHG02-SD-04
		CO-NCC-CHG02-SS-03
		Method Blank
		Laboratory Matrix Duplicate
		Matrix Spike (MS)/Matrix Spike Duplicate (MSD)
		Laboratory Control Sample (LCS)
WG11267	Metals (soil)	CO-NCC-CHG02-SS14
		CO-NCC-CHG02-SD04
		CO-NCC-CHG02-SS03
		CO-NCC-CHG02-SS13
		CO-NCC-CHG02-SS20
		CO-NCC-CHG02-SS21
		CO-NCC-LGG02-SS25
		CO-NCC-LGG02-SS26
		CO-NCC-LGG02-SS26 dup
		CO-NCC-CHG02-SS05
		CO-NCC-CHG02-SD04 dup
		CO-NCC-CHG02-SS18
		CO-NCC-LGG02-SS27
		CO-NCC-LGG02-SS33
		Method Blank
		Laboratory Matrix Duplicate
		MS/MSD
		LCS

Batch	Analyses	Sample ID
WG11268	Metals (soil)	CO-NCC-LGG02-SS37
		CO-NCC-LGG02-SS37 dup
		CO-NCC-LGG02-SS36
		CO-NCC-LGG02-SS22
		CO-NCC-LGG02-SS34
		CO-NCC-LGG02-SS31
		CO-NCC-LGG02-SS32
		Method Blank
		Laboratory Matrix Duplicate
		MS/MSD
		LCS
WG11333	Metals (water leachate)	CO-NCC-CHG02-SS11
		CO-NCC-CHG02-SS10
		CO-NCC-CHG02-SS11 dup
		CO-NCC-CHG02-SS09
		CO-NCC-CHG02-SD-01
		CO-NCC-CHG02-SD02
		CO-NCC-CHG02-SS07
		CO-NCC-CHG02-SS06
		CO-NCC-CHG02-SS04
		CO-NCC-CHG02-SS16
		CO-NCC-CHG02-SS15
		CO-NCC-CHG02-SS02
		CO-NCC-CHG02-SS08
		CO-NCC-CHG02-SS08 dup
		CO-NCC-CHG02-SD-03
		CO-NCC-CHG02-SS14
		CO-NCC-CHG02-SD-04
		CO-NCC-CHG02-SS-03
		Method Blank
		Laboratory Matrix Duplicate
		MS/MSD
		LCS
WG11334	Metals (water leachate)	CO-NCC-CHG02-SS13
		CO-NCC-CHG02-SS20
		CO-NCC-CHG02-SS21
		CO-NCC-LGG02-SS25
		CO-NCC-LGG02-SS26
		CO-NCC-LGG02-SS26 dup
		CO-NCC-CHG02-SS05
		CO-NCC-CHG02-SD04 dup
		CO-NCC-CHG02-SS18
		CO-NCC-LGG02-SS27
		CO-NCC-LGG02-SS33

Batch	Analyses	Sample ID
		CO-NCC-LGG02-SS37
		CO-NCC-LGG02-SS37 dup
		CO-NCC-LGG02-SS36
		CO-NCC-LGG02-SS22
		CO-NCC-LGG02-SS34
		CO-NCC-LGG02-SS31
		CO-NCC-LGG02-SS32
		Method Blank
		Laboratory Matrix Duplicate
		MS/MSD
		LCS
M020912	Water Leachate Conductivity	CO-NCC-CHG02-SS11
		CO-NCC-CHG02-SS10
		CO-NCC-CHG02-SS11 dup
		CO-NCC-CHG02-SS09
		CO-NCC-CHG02-SD-01
		CO-NCC-CHG02-SD02
		CO-NCC-CHG02-SS07
		CO-NCC-CHG02-SS06
		CO-NCC-CHG02-SS04
		CO-NCC-CHD02-SS16
		CO-NCC-CHG02-SS15
		CO-NCC-CHG02-SS02
		CO-NCC-CHG02-SS08
		CO-NCC-CHG02-SS08 dup
		CO-NCC-CHG02-SD-03
		Method Blank
		Laboratory Matrix Duplicate
		LCS
M020922	Water Leachate Conductivity	CO-NCC-CHG02-SS14
		CO-NCC-CHG02-SD04
		CO-NCC-CHG02-SS03
		CO-NCC-CHG02-SS13
		CO-NCC-CHG02-SS20
		CO-NCC-CHG02-SS21
		CO-NCC-CHG02-SS25
		CO-NCC-CHG02-SS26
		CO-NCC-CHG02-SS26 dup
		CO-NCC-CHG02-SS05
		CO-NCC-CHG02-SD04 dup
		CO-NCC-CHG02-SS18
		CO-NCC-LGG02-SS27
		CO-NCC-LGG02-SS33
		CO-NCC-LGG02-SS37

Batch	Analyses	Sample ID
		CO-NCC-LGG02-SS37 dup
		CO-NCC-LGG02-SS36
		CO-NCC-LGG02-SS22
		CO-NCC-LGG02-SS34
		CO-NCC-LGG02-SS31
		CO-NCC-LGG02-SS32
		Method Blank
		Laboratory Matrix Duplicate
		LCS/LCSD
M020912	Water Leachate pH	CO-NCC-CHG02-SS11
		CO-NCC-CHG02-SS10
		CO-NCC-CHG02-SS11 dup
		CO-NCC-CHG02-SS09
		CO-NCC-CHG02-SD-01
		CO-NCC-CHG02-SD02
		CO-NCC-CHG02-SS07
		CO-NCC-CHG02-SS06
		CO-NCC-CHG02-SS04
		CO-NCC-CHG02-SS16
		CO-NCC-CHG02-SS15
		CO-NCC-CHG02-SS02
		CO-NCC-CHG02-SS08
		CO-NCC-CHG02-SS08 dup
		CO-NCC-CHG02-SD-03
		pH = 4.0
		PH = 7.0
M020922	Water Leachate pH	CO-NCC-CHG02-SS14
		CO-NCC-CHG02-SD04
		CO-NCC-CHG02-SS03
		CO-NCC-CHG02-SS13
		CO-NCC-CHG02-SS20
		CO-NCC-CHG02-SS21
		CO-NCC-LGG02-SS25
		CO-NCC-LGG02-SS26
		CO-NCC-LGG02-SS26 dup
		CO-NCC-CHG02-SS05
		CO-NCC-CHG02-SD04
		CO-NCC-CHG02-SS18
		CO-NCC-LGG02-SS27
		CO-NCC-LGG02-SS33
		CO-NCC-LGG02-SS37
		CO-NCC-LGG02-SS37 dup
		CO-NCC-LGG02-SS36
		CO-NCC-LGG02-SS22

Batch	Analyses	Sample ID
		CO-NCC-LGG02-SS34
		CO-NCC-LGG02-SS31
		CO-NCC-LGG02-SS32
		pH = 4.0
		pH = 7

5 RESULTS OF QUALITY CONTROL ACTIVITIES AND ANALYSES

Field QC activities consisted of collecting appropriate field QC samples (field duplicates, trip blanks), daily communication between the CENWO field team and ECB Lab, and consistent interaction between the CENWO field team and CENWO Technical Manager.

5.1 FIELD QC PROCEDURES AND FIELD QC ANALYSES

5.1.1 Documentation of Field Quality Procedures

Daily Reports and Daily Quality Control Reports (DQCRs) were completed to summarize daily investigation procedures and document QC activities. These reports summarize samples collected, environmental conditions, instrument problems, and any non-routine situations that may have impacted sample integrity. These reports were reviewed concurrently with the COC forms and the analytical results from the laboratories to identify potential sampling anomalies or confirm sample identifications. The DQCR reports show collection procedures were adequate to ensure data results met project objectives.

5.1.2 Field Duplicate Analyses

Field duplicate samples were collected as indicated in Table 4-1, and also one sample in each batch for metals was run in duplicate for precision for the batch can be determined. Relative percent difference (RPD) of each analyte was within compliance so no qualification was required for the metals results because of precision for the soils and soils leachate. Field duplicates were analyzed for five sets of samples for conductivity, pH, and acidity and the RPDs were within criteria, so no qualifications were applied.

5.2 LABORATORY QC PROCEDURES AND LABORATORY QC ANALYSES

The USACE project chemist conducted a review of laboratory QC procedures. All issues identified, and their respective solutions are discussed below and required qualifications are given in section 5.

5.2.1 Initial Sample Inspection and COC Documentation

ECB Laboratory inspected all shipping containers and compared the contents with the appropriate COC documentation. Information from the sample check-in procedures was recorded on the Cooler Receipt Form. This form was used to document that samples listed on the COC forms agreed with samples contained in the coolers, COC forms were filled out properly, samples were not broken, custody seals were intact, and cooler temperatures were less than or equal to 4^{o}C. These forms are included in the Analytical Data Packages. No problems or deficiencies were found with the sample shipments or COC documentation.

5.2.2 Holding Times

Samples were delivered daily by the overnight courier to ECB Laboratory to ensure all analyses were completed within the required holding times. Part of the CENWO chemist evaluation included reviewing sample extraction and analysis dates to ensure holding times were met. Based on CENWO's review of the laboratory data, all samples were extracted and analyzed within the required holding times.

5.2.3 Method Blank Analyses

Method blanks were analyzed to assess existence and magnitude of contamination problems and measure the representativeness of the analytical process. Blanks reflect the amount of contamination introduced into the environmental samples during sample collection, transfer from the site to the laboratory or analysis. In particular, method blanks reflect laboratory contamination from both the determinative and preparatory method. At least one method blank must be reported for each preparation batch of samples. All blanks were clean except in the following:

Analytical Batch:

WG11258: Cu = 1.0 mg/Kg
Zn = 2.0 mg/Kg

No qualification since the sample values for these metals were greater than 10 times the blank contamination.

WG11267: Cu = 2.6 mg/Kg
Zn = 2.2 mg/Kg

No qualification since the sample values for these metals were greater than 10 times the blank contamination.

WG111268: Zn = 0.6J mg/Kg

No qualification since the sample values for these metals were greater than 10 times the blank contamination.

5.2.4 Laboratory Control Samples

Laboratory control samples are evaluated to assess overall method performance and are the primary indicators of laboratory performance. Laboratory control samples are method blanks which are typically spiked with all target analytes of interest. The percent recovery is used as a measure of accuracy and bias. The relative percent difference (RPD) for duplicate LCS recoveries is normally used as a measure of precision. When both a laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) are processed for a batch of samples, there is no significant physical distinction between the LCS and the LCSD. Both the LCS and the LCSD must satisfy the same recovery acceptance criteria. At least one LCS must be reported with each batch of samples. Multiple LCSs may be required to evaluate method precision. For example, a laboratory control sample and a laboratory control sample duplicate (LCSD) may be analyzed to provide information on the precision of the analytical method. The generation of control chart limits for precision via the analysis of LCS/LCSD pairs is an effective means to measure method precision. LCS and LCSD results are included in the QC section of the laboratory's data package. No qualifications were applied due to the LCS. The recoveries were with set criteria for all metals and conductivity results.

5.2.5 Surrogate Recovery

Surrogates are organic compounds, which are similar in chemical composition to the analytes of interest. Surrogates are spiked into environmental and batch QC samples prior to sample preparation and analysis. Surrogate recoveries for environmental samples are used to evaluate matrix interference on a sample-specific basis. High or low surrogate recoveries indicate problems in instrument performance, extraction procedures, or severe matrix effects. Samples for metals analysis are not spiked with surrogate analytes. No surrogate is added to samples for conductivity analysis.

5.2.6 MS/MSD Recovery

Matrix Spike (MS) and matrix spike duplicate (MSD) results are examined to evaluate the impact of matrix effects on overall analytical performance. A matrix spike is a representative environmental sample that is spiked with target analytes of interest prior to being taken through the entire analytical process in order to evaluate analytical bias for an actual matrix. A matrix duplicate is a collocated or a homogenized sample that is processed through the entire analytical procedure in order to evaluate overall precision for an actual matrix.

It should be noted that MS recovery failure and poor precision may arise because of (i) poor sampling technique, (ii) inadequate homogenization, or (iii) from matrix effects associated with the preparatory or determinative portion of an analytical method. Matrix interferences may be "positive" or "negative" in nature. Results of MS/MSD analyses are included in the Analytical Data Packages.

Metals: One set of MS/MSD samples were analyzed for each metals analytical batch. Analytical batches WG11258, WG11267, and WG11268 had recoveries and/or RPD values our of criteria.

WG11258 and WG11268: Aluminum and Zinc MS recoveries were each high, but the % recovery determination would be hard due to high initial sample concentration. The MS/MSD RPD was generally acceptable. All other quality control indicators were acceptable for these batches. No qualifications were applied to the data in these batches.

WG11267: Lead has erratic MS recoveries for this analytical batch. It may be due to high initial samples concentrations of lead. All other quality control indicators were acceptable for this batch. No qualifications were applied to the data in this batch.

5.2.7 Completeness of Data Packages

The CENWO Chemist reviewed the data package and confirmed the completeness of the data package. All the planned sampling activities were executed and all the laboratory analyses were performed.

5.3 PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS AND COMPARABILITY (PARCC)

DQOs and their corresponding measurement indicators were specified in the Sampling and Analysis Plan. To achieve the project DQOs, specific PARCC goals are established for laboratory and field sampling procedures. These PARCC parameters are the measurement tools for determining the usability of generated data.

Precision and accuracy goals were based on knowledge of each analytical measurement system. For this CDQAR, precision was measured using the RPD between two replicated sample analyses. The precision evaluation encompassed laboratory precision (LCS samples), and combined field/laboratory precision (MS/MSD samples).

Accuracy was measured using the percent recovery of surrogates, MS/MSD samples, and LCS sample pairs. Spike recoveries form field samples and laboratory QC samples are compared to established control limits to determine a laboratory's ability to accurately determine both qualitative and quantitative results.

Representativeness is the degree to which the data accurately and precisely portrayed the environmental conditions being studied. For the site investigation, sampling procedures and sample locations were selected to bias samples in areas of potential places of contamination. All sampling was conducted using known approved field procedures to minimize variability.

Completeness refers to the amount of valid data obtainable from a measurement system compared to the expected amount of data. The SAP established a completeness goal of 90 percent for laboratory QC requirements. This goal was attained by the data for this project.

5.4 DATA TABLES

The qualified data is given in Appendix A.

5.5 ANALYTICAL DATA PACKAGE

Data Sheets as Obtained from Environmental Chemistry Laboratory will be given upon request as hard copy of the Analytical Data Package.

6 CONCLUSIONS

This CDQAR presents, in specific terms, the quality control practices utilized to achieve the goals of the site investigation at North Fork of Clear Creek, Colorado. The analytical program for this project conformed to the CENWO General Chemistry SOS and the General Geology SOS. Samples were also collected and analyzed in accordance with ASTM and EPA methods and laboratory specific QA/QC procedures were used. These procedures were followed to generate high quality data.

The quality issues addressed in Section 5 of this report do not impact the usability of the data. The required qualifications have been applied to the data in Appendix A, Table 1, and 2. The reviewed data are usable and are suitable for addressing the overall objective of this investigation.

Appendix A